MICHAEL J. GAMBUZZA | GE SENSING & INSPECTION TECHNOLOGIES michael.gambuzza@ge.com

Gyrator Circuit Makes DC Supply Invisible For AC Testing

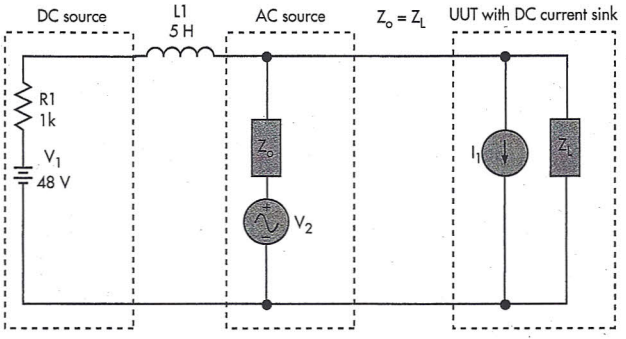
Designers have long used the gyrator circuit to create a virtual inductor employing readily available capacitors. The circuit can achieve high inductance values with relatively low capacitance values, making it easy to implement, less bulky per unit inductance, and more cost effective than physical inductors.

This idea shows how a gyrator can also be used to permit certain ac tests on a unit under test (UUT) that requires a dc current feed. Typical examples include devices that connect to the telephone line such as modems, fax machines, and Voice over Internet Protocol (VoIP) equipment. These devices require a current feed that will not disturb the ac termination impedance.

A specific example would be a UUT powered by a 48-V dc source *(Fig. 1)*. The UUT typically has a dc current sink with high ac impedance implemented by the UUT's gyrator circuit. It also has a specified termination impedance across the current sink. For equipment connected to a telephone line, this could be 600 Ω. Signal generator V2 in series with source termination Z_o is connected to the UUT to make ac measurements. L1 provides the ac isolation so the power supply does not load down the ac signal.

However, for voice-band equipment, where the bandwidth can be from 300 Hz to 4 kHz, the inductor must be relatively large to provide enough isolation impedance between the generator and dc supply. At 300 Hz while using a 5-H inductor, the inductive reactance is:

$$X_L = 2\pi fL = 2\pi(300)(5) = 9424\ \Omega$$



1. To make ac measurements on a unit under test that requires a dc feed, such as a device that connects to a telephone line, designers must add a rather large, expensive inductor.

This is much greater than the 600-Ω UUT termination and therefore typically will suffice for ac isolation.

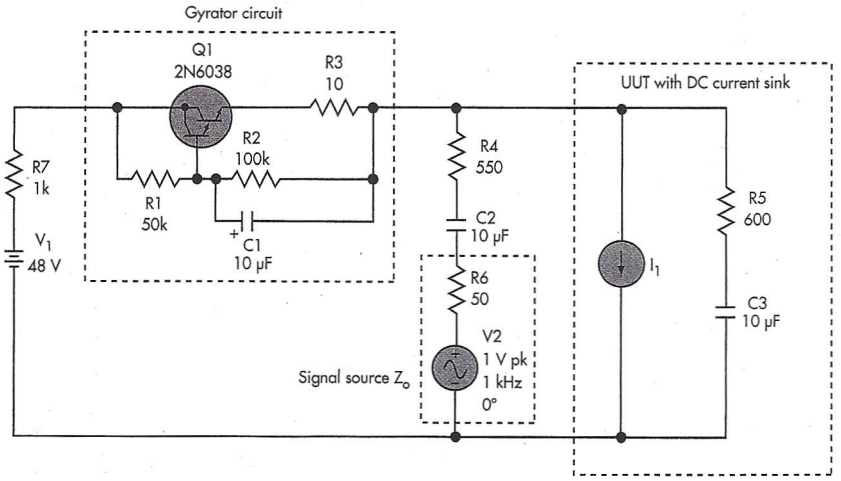
Unfortunately, for a test fixture, the 5-H inductor is fairly large and expensive. Replacing the large inductor with a two-port gyrator circuit can provide an effective alternative *(Fig. 2)*. The circuit's inductance value can be approximated by:

$$L = (R1)(C1)(R3)H$$

The signal source, consisting of V2 and R6, provides a typical 50-Ω generator output. R4 and R6 sum to match the termination impedance of the UUT—600 Ω. C2 is a dc blocking capacitor.

The UUT includes a current sink, I_1, and a termination network, R5 and C3. This setup allows designers to perform some typical ac tests, such as return loss, total harmonic distortion, and frequency response.

When implementing the circuit, be sure to calculate the maximum power dissipation in Darlington Q1 to ensure you do not exceed the transistor's power capability. Also, make sure you are using a current-limited supply.



2. An alternative setup uses a gyrator circuit to implement a virtual inductance.

MICHAEL J. GAMBUZZA is currently a lead design engineer for GE Sensing. He has 27 years of mixed-signal design experience.